Innovation in feed additives

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Engineering your feed solutions
Innovation in feed additives

- Introduction
- Feed additives by category
- Development of feed additives developments over time
- Case study 1: Emulsifiers
- Case study 2: Selenium
- Future fields of research
Categories of feed additives

Source: Fefana
### Categories of feed additives

#### Classification of basic feed additives

<table>
<thead>
<tr>
<th>Nutritional feed additives</th>
<th>Non- nutritional feed additives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amino Acids</td>
<td><strong>Technological additives</strong></td>
</tr>
<tr>
<td>Minerals</td>
<td>(enzymes, emulsifiers, preservatives, antioxidants, stabilizers, acidity regulators,....)</td>
</tr>
<tr>
<td>Vitamins</td>
<td><strong>Zootechnical additives</strong></td>
</tr>
<tr>
<td>Micronutrients</td>
<td>(digestibility enhancers, gut flora stabilizers,....)</td>
</tr>
<tr>
<td></td>
<td><strong>Sensory additives</strong></td>
</tr>
<tr>
<td></td>
<td>(flavours, colourants, ...)</td>
</tr>
<tr>
<td></td>
<td><strong>Coccidiostats and histomonats</strong></td>
</tr>
</tbody>
</table>

Source: European Commission; Regulation (EC) No 1831/2003
Developments over time (Amino Acids)

Crude Protein Level

- Protein from raw materials only
- 60’s: introduction of feedgrade Lysine
- 70’s: introduction of Methionine
- 80’s: Introduction of Threonine
- 00’s: introduction of Tryptophan
- 10’s: introduction of Valine
- Future developments; next limiting amino acid, peptides, functional applications, organic foods

Source: adjusted from Ajinomoto and Evonik
Developments over time (Minerals)

<table>
<thead>
<tr>
<th>Inorganic</th>
<th>Hydroxy</th>
</tr>
</thead>
<tbody>
<tr>
<td>A specific metal bound to a non-carbon-containing ligand. Developed in the 1950’s</td>
<td>A specific metal bound via a coordinated covalent bond with a hydroxy ligand. Developed in late 1990’s</td>
</tr>
</tbody>
</table>
| ZnO; CuO; MnO; CuSO₄; ZnSO₄; MnSO₄; ... | Zn₅(OH)₈Cl₂·H₂O  
Zinc chloride hydroxide monohydrate  
Cu₂(OH)₃Cl  
Dicopper chloride trihydroxide |

<table>
<thead>
<tr>
<th>Organic</th>
</tr>
</thead>
<tbody>
<tr>
<td>A specific metal bound to a carbon-containing ligand. Developed in the 1970’s</td>
</tr>
<tr>
<td>Zn-Aminoacid-Complex; Cu-Chelate; Glycinates; ...</td>
</tr>
</tbody>
</table>

Spectrum of Bond Strength

- **Too Weak**  
  (e.g., sulfates, organic acid salts)

- **“Sweet Spot”**  
  (e.g., hydroxy trace minerals)

- **Too Strong**  
  (e.g., oxides, EDTA)

Source: adjusted from MicroNutrients
Developments over time (Gut level)

- FEED HYGIENE (ORGANIC ACIDS)
- PATHOGEN CONTROL (PLANT EXTRACT / COATED OA / MCFA)
- BALANCED MICROFLORA (PRO- AND PREBIOTICS / BACTERIOPHAGES)
- INTESTINAL HEALTH (VILLI/CRYPTH TIGHT JUNCTIONS CELL METABOLISM)
- DIET-HOST INTERACTION (IMMUNE MODULATION GENE EXPRESSION)
- MICROFLORAL COMMUNICATION (QUORUM SENSING)
Quorum sensing—innovation driven by new field of research

Peer-reviewed literature search (via scopus): “quorum sensing”

> 30% published in last 3 years
Quorum sensing– innovation driven by new field of research

New field of research opens doors for:

• New molecules
  Quenching Enzymes
  Others?

• New applications for existing molecules:
  Probiotics
  Plant extracts

• Evaluation of existing molecules
  Parameter to measure pathogenicity

Cheng ea (2015)- Substitution of antibiotics in animal husbandry

Novita ea (2015)- Probiotic Bacillus Sp. produces AHL Lactonase

Yang ea (2015)- Tannin rich pommegranate inhibits QS in E.Coli
Case study 1: Progress in emulsifiers

First reports on application of soy-derived lecithin in animal feed industry starts around 1985
(Sontag ea (1985)- Growth potential of soybean oil products for industrial materials)

In 5-10 years time development of (modified) lysolecithins started
(Jones ea (1992)- Effects of exogenous emulsifiers on digestion and performance in weaning piglets)

Awareness on importance of HLB values allows introduction of new molecules
(Maertens ea (2013)- The effect of different emulsifiers on fat and energy digestibility in broilers)
Case study 1: Progress in emulsifiers

- Hydrophilic-Lipophilic Balance (HLB); Concept for choosing emulsifiers
- Based on old knowledge; Rule of Bancroft (1912): “The emulsifier should be soluble in the continuous phase”
- Range from 1-20
## Emulsifiers – innovation driven by knowledge functional properties

<table>
<thead>
<tr>
<th>Diet</th>
<th>HLB</th>
<th>Fat dig. (%)</th>
<th>CP dig. (%)</th>
<th>GE dig. (%)</th>
<th>ME kJ/kg DM</th>
<th>N ret. kJ/kg</th>
<th>MEn/kg DM kcal</th>
<th>Upgrade (kcal) vs control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>63.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>56.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>68.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13 907&lt;sup&gt;a&lt;/sup&gt;</td>
<td>759&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13 149&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3143&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Emulsifier A</td>
<td>13,2</td>
<td>68.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>60.1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>71.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14 493&lt;sup&gt;b&lt;/sup&gt;</td>
<td>802&lt;sup&gt;d&lt;/sup&gt;</td>
<td>13 691&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3272&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Emulsifier B</td>
<td>16,7</td>
<td>70.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>59.7&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>71.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14 519&lt;sup&gt;b&lt;/sup&gt;</td>
<td>797&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>13 723&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3280&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Emulsifier C</td>
<td>13,5</td>
<td>68.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>58.1&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>70.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14 356&lt;sup&gt;b&lt;/sup&gt;</td>
<td>776&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>13 589&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3246&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Emulsifier D</td>
<td>&gt;15</td>
<td>67.5&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>58.5&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>71.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14 509&lt;sup&gt;b&lt;/sup&gt;</td>
<td>781&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>13 728&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3281&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

*Maertens et al (2013), The effect of different emulsifiers on fat and energy digestibility in broilers*
Case study 2: Progress in Selenium nutrition

Originally selenium was derived from raw materials

Introduction of supplemented selenium via inorganic sources (selenite/selenate)
(FDA approval by 1974; Ammerman ea (1975)- Selenium in ruminant nutrition-a review)

Launch of highly available selenium from organic source (selenized yeast)
(Lyons ea (2007)-Selenium in food chain and animal nutrition- review)

Awareness that Selenomethionine is the active ingredients of main interest and introduction of L-Selenomethionine as such
(Delezie ea (2014)- Comparing responses to different selenium sources and dosages in laying hens)
Selenized Yeast | Commercial sample review 2015

Se as SeMet, % of total Se

Similar spread has been reported in a large variety of peer reviewed publications:
Schrauzer ea (2006); Zhan ea (2011); Wrobel ea (2003); McSheehy ea (2005); Yoshida ea (2002); Yang ea (2004); Ip ea (2001); Larsen ea (2004); Wolf ea (2001); Polotajko ea (2005)
L-Selenomethionine

• New source of organic selenium
• EU registration
  • EU regulation No 121/2014
  • Category 3b (compound of trace element)
  • Nutritional additive for use in all animal species
• Close to 100% available as L-Selenomethionine
• No variation in Selenomethionine level
• Selenomethionine is not bounded in protein structure allowing higher digestibility
**Trial results laying hens**

Selenium in eggs (µg/kg), d56

- Dose response effect of the different Se sources on Se concentrations in eggs
- L-Selenomethionine has significant higher transfer compared to SeYeast

*Delezie et al (2014); Comparing responses to different selenium sources and dosages in laying hens*
Issues in animal production

- Greenhouse gases
- Land scarcity
- Biodiversity
- Climate change

- Global increase for more animal protein
- Organic production
- Animal welfare

- Registration
- Legislation on animal husbandry
- Subsidies

- Animal diseases / Zoonoses
- Antibiotic resistance
- Functional foods

Environment
Consumer wishes
Government
Health
Thank you for your attention

ORFFA

Engineering your feed solutions